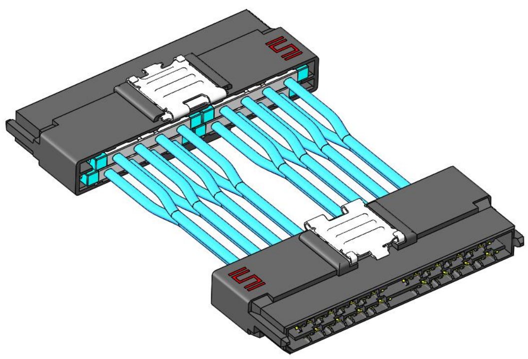
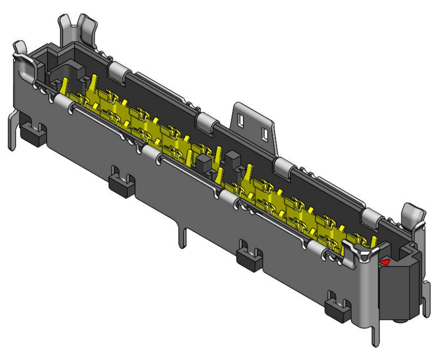
High Speed Characterization Report

NVAC-DP-3-02-2-XX.X-01-1-L



Mated with:

NVAM-DP-02-2-02.0-S-2-C



Description:
0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly
2-row, 2-bank, 92-ohm Twinax Cable

Samtec Inc.
520 Park East Blvd.
New Albany IN 47151-1147 USA

WWW.SAMTEC.COM
1-800-SAMTEC-9 (US & Canada)
SIG@samtec.com

Phone: 812-944-6733
Fax: 812-948-5047
Report Revision: 09/07/2020

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Table of Contents

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Cable Assembly Overview

The NVAC series is a NovaRay® 0.8 mm extreme density and performance socket cable assembly. It is constructed using 34 AWG Eye Speed® ultra-low skew twinax cable (available in 92-ohm and 100-ohm differential impedance). The cable is terminated at each end with NovaRay® socket connectors. The cable assembly is wired to facilitate a Pin A01 to Pin AN (N = last position in row) mapping between the cable terminations.

NVAC cable assemblies have been designed to support 1 to 3 banks of contacts with a minimum of 8 pairs per bank (2 row) up to 24 pairs per bank (6 row). The data in this report reflects performance of the 2 row, 2 bank, 92-ohm twinax cable version; with cable lengths of 250 mm, 500 mm and 1000 mm.

Each NVAC cable assembly was tested by mating it to NVAM-C series header connector at both ends. One sample of each assembly was tested. The actual part numbers that were tested are shown in Table 1, which also identifies End 1 and End 2 of each assembly. A relative sample picture is shown in Figure1.

Length	Part Number	End 1	End 2
250 mm	NVAC-DP-3-02-2-10.0-01-1-L	NVAF	NVAF
500 mm	NVAC-DP-3-02-2-20.0-01-1-L	NVAF	NVAF
1000 mm	NVAC-DP-3-02-2-40.0-01-1-L	NVAF	NVAF

Table 1: Sample Description

Figure 1: Test Sample

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Frequency Domain Data Summary

Bandwidth Figures – Differential Insertion Loss

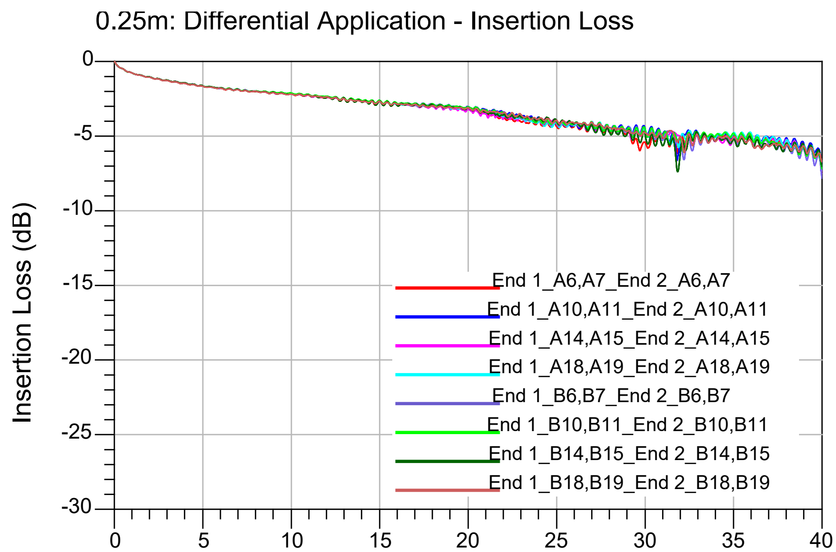


Figure 2

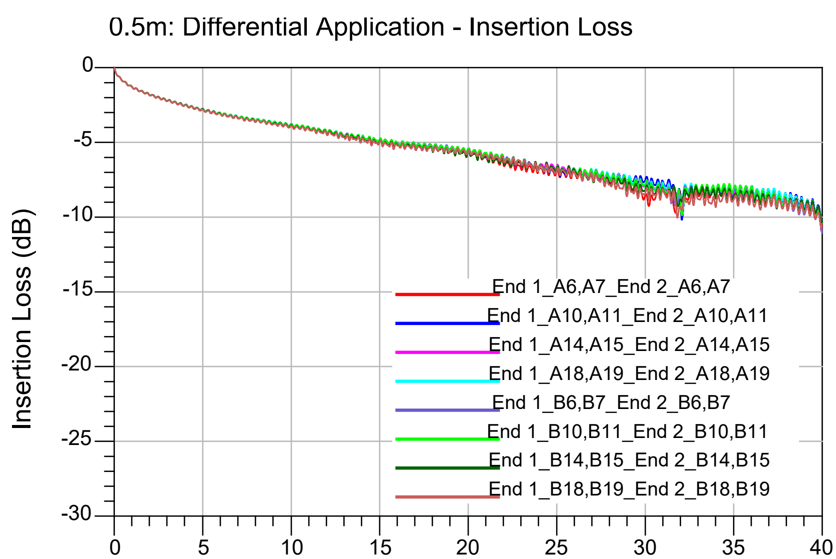


Figure 3

Samtec Inc.
520 Park East Blvd.
New Albany IN 47151-1147 USA

WWW.SAMTEC.COM
1-800-SAMTEC-9 (US & Canada)
SIG@samtec.com

Phone: 812-944-6733
Fax: 812-948-5047
Report Revision: 09/07/2020

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

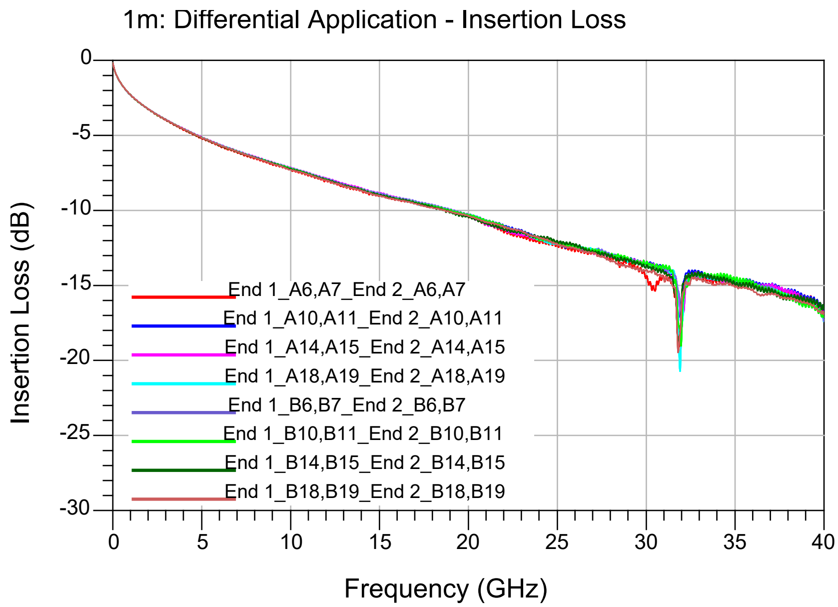


Figure 4

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Time Domain Data Summary

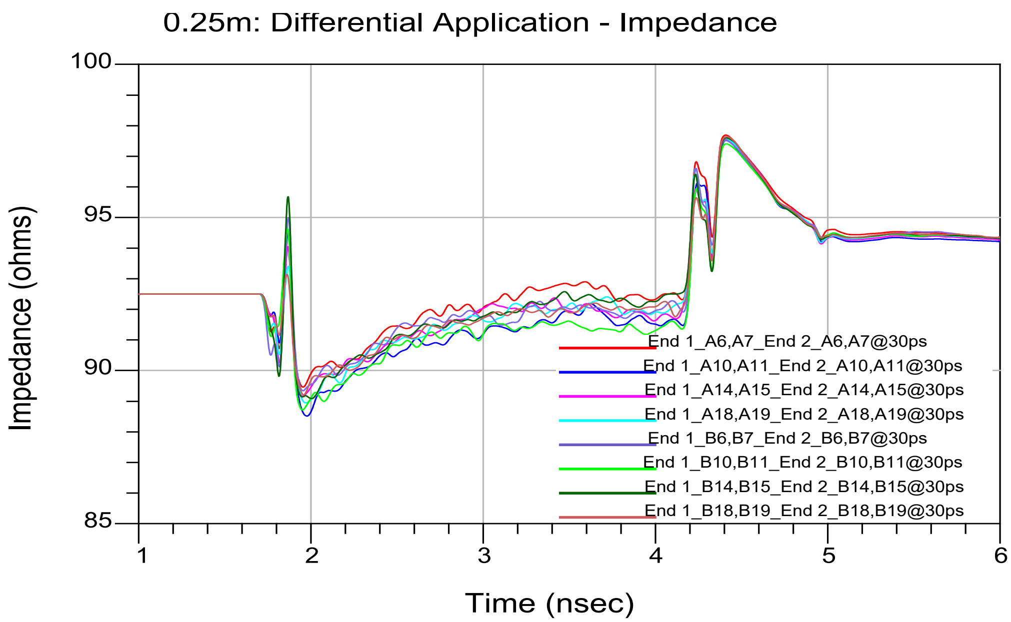


Figure 5

Because the same type cable is used in the cable assemblies with different lengths, only the impedance profile of 0.25 m cable assembly is reported.

Table 2 - Propagation Delay (Cable Assembly)

Driver	Receiver	0.25 m	0.5 m	1 m
End 1_A6, A7	End 2_ A6, A7	1.301 ns	2.494 ns	4.854 ns
End 1_A10, A11	End 2_A10, A11	1.301 ns	2.493 ns	4.855 ns
End 1_A14, A15	End 2_A14, A15	1.300 ns	2.493 ns	4.854 ns
End 1_A18, A19	End 2_A18, A19	1.299 ns	2.492 ns	4.858 ns
End 1_B6, B7	End 2_B6, B7	1.300 ns	2.492 ns	4.857 ns
End 1_B10, B11	End 2_B10, B11	1.301 ns	2.493 ns	4.856 ns
End 1_B14, B15	End 2_B14, B15	1.300 ns	2.493 ns	4.857 ns
End 1_B18, B19	End 2_B18, B19	1.299 ns	2.494 ns	4.857 ns

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Characterization Details

This report presents data that characterizes the signal integrity response of a cable assembly in a controlled printed circuit board (PCB) environment. All efforts are made to reveal typical best-case responses inherent to the system under test (SUT).

In this report, the SUT includes the mating connectors, cable assembly, and footprint effects on a typical multi-layer PCB. PCB effects (trace loss) are de-embedded from test data. Board related effects, such as pad-to-ground capacitance, are included in the data presented in this report.

Additionally, intermediate test signal connections can mask the cable assembly's true performance. Such connection effects are minimized by using high performance test cables and adapters. Where appropriate, calibration and de-embedding routines are also used to reduce residual effects.

Differential and Single-Ended Data

Most Samtec cable assemblies can be used successfully in both differential and single-ended applications. However, electrical performance will differ depending on the signal drive type. In this report, data is presented for "GSSG" differential drive configuration only.

Cable assembly Signal to Ground Ratio

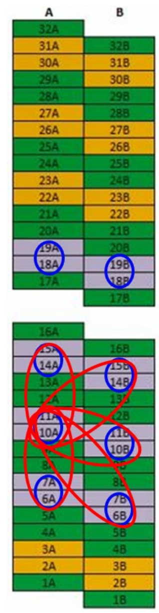
Samtec cable assemblies are most often designed for generic applications and can be implemented using various signal and ground pin assignments. In high speed systems, provisions must be made in the interconnect for signal return currents. Such paths are often referred to as "ground". In some cable assemblies, a ground plane or blade, or an outer shield, is used as the signal return, while in others, cable assembly pins are used as signal returns. Various combinations of signal pins, ground blades, and shields can also be utilized. Electrical performance can vary significantly depending upon the number and location of ground pins.

In general, the more pins dedicated to ground, the better electrical performance will be. But dedicating pins to ground reduces signal density of a cable assembly. Therefore, care must be taken when choosing signal/ground ratios in cost or density-sensitive applications.

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

For this cable assembly, the following configurations are evaluated:

Potential NEXT aggressors, depending on pinout



Potential FEXT aggressors, depending on pinout

Differential Impedance (denoted by blue circles):
- GSSG (Ground-positive signal-negative signal-Ground)

Differential Crosstalk (denoted by red circles):
- In row: from the terminals to the other terminals on the same row.
- Across row: from one row of terminals to the other row of terminals.

See Appendix C – Product and Test System Descriptions for details

Other configurations can be evaluated upon request. Please contact sig@samtec.com for more information.

In a real system environment, active signals might be located at the outer edges of the signal contacts of concern, as opposed to the ground signals utilized in laboratory testing. For example, in a single-ended system, a pin-out of "SSSS", or four adjacent single ended signals might be encountered as opposed to the "GSG" and "GSSG" configurations tested in the laboratory. Electrical characteristics in such applications could vary slightly from laboratory results. But in most applications, performance can safely be considered equivalent.

Signal Edge Speed (Rise Time)
In pulse signaling applications, the perceived performance of the interconnect can vary significantly depending on the edge rate or rise time of the exciting signal. For this report, the fastest rise time used was 30 ps. Generally, this should demonstrate worst-case performance.

In many systems, the signal edge rate will be significantly slower at the cable assembly than at the driver launch point. To estimate interconnect performance at other edge rates, data is provided for several rise times between 30 ps and 100 ps.

For this report, measured rise times were at 20%-80% signal levels.

Frequency Domain Data
Frequency Domain parameters are helpful in evaluating the cable assembly system's signal loss and crosstalk characteristics across a range of sinusoidal frequencies. In this report, parameters presented in the Frequency Domain are Insertion Loss, Return Loss, Near-End and Far-End Crosstalk, and Mode Conversion. Other parameters or formats, such as VSWR or S-Parameters, may be available upon request. Please contact our Signal Integrity Group at sig@samtec.com for more information.

Frequency performance characteristics for the SUT are generated directly from network analyzer measurements.

Time Domain Data
Mathematically, Frequency Domain data can be transformed to obtain a Time Domain response. Perfect transformation requires Frequency Domain data from DC to infinity Hz. Fortunately, a very accurate Time Domain response can be obtained with bandwidth-limited data, such as measured with modern network analyzer.

The Time Domain responses were generated using Agilent ADS 2016.01. This tool has a transient convolution simulator, which can generate a Time Domain response directly from measured S-Parameters. An example of a similar methodology is provided in the Samtec Technical Note on domain transformation.
http://www.samtec.com/Technical_Library/reference/articles/pdfs/tech-note_using-PLTS-for-time-domain-data_web.pdf

The measured S-Parameters from the network analyzer are post-processed using Keysight ADS to obtain the time domain response for signal propagation time. The Time Domain procedure is provided in Appendix D of this report. Parameters or formats not included in this report may be available upon request. Please contact our Signal Integrity Group at sig@samtec.com for more information.

In this report, propagation delay is defined as the signal propagation time through the cable assembly, mating connectors, and connector footprint. It also includes 2.937 mm of PCB trace on each connector side. Delay is measured at 50 picoseconds signal rise-time. Delay is calculated as the difference in time measured between the 50% amplitude levels of the input and output pulses.

Data for other configurations may be available. Please contact our Signal Integrity Group at sig@samtec.com for further information.

Additional information concerning test conditions and procedures is located in the appendices of this report. Further information may be obtained by contacting our Signal Integrity Group at sig@samtec.com.

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Appendix A – Frequency Domain Responses

Differential Application – Insertion Loss

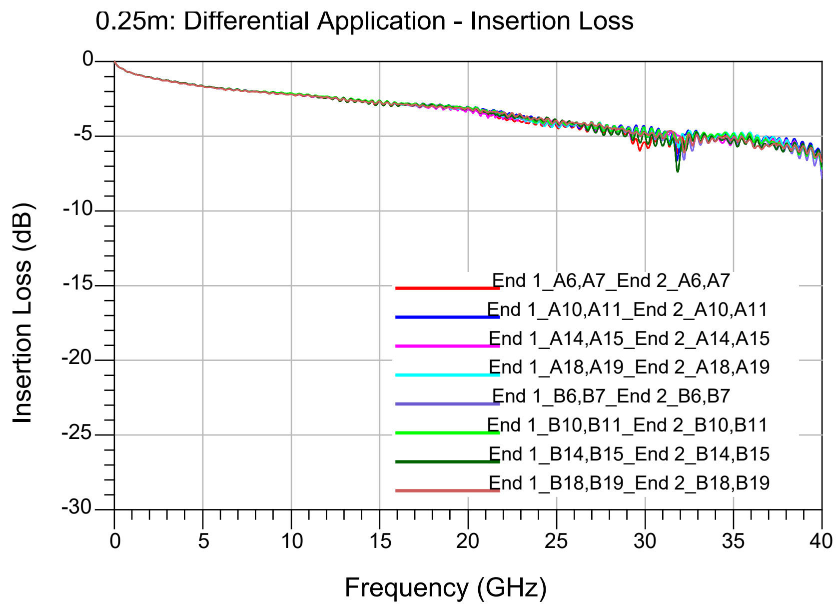


Figure 6

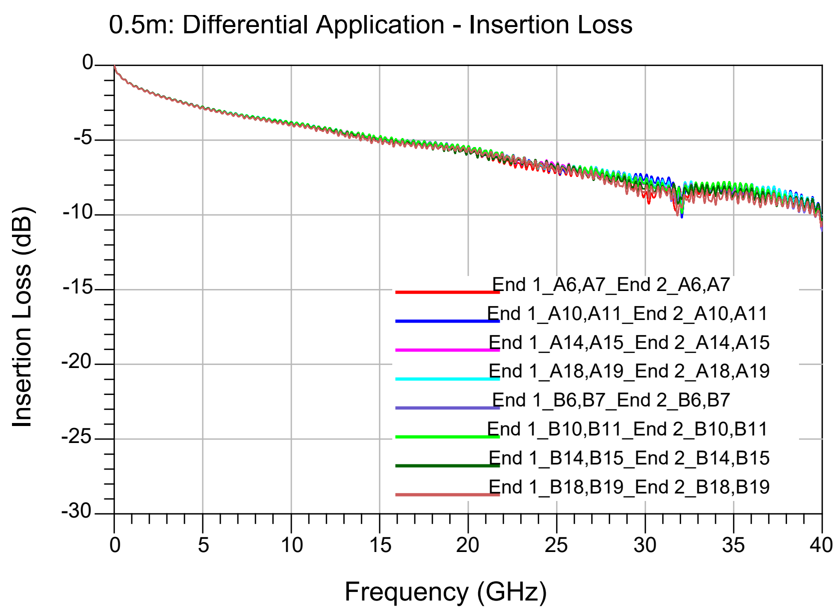


Figure 7

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

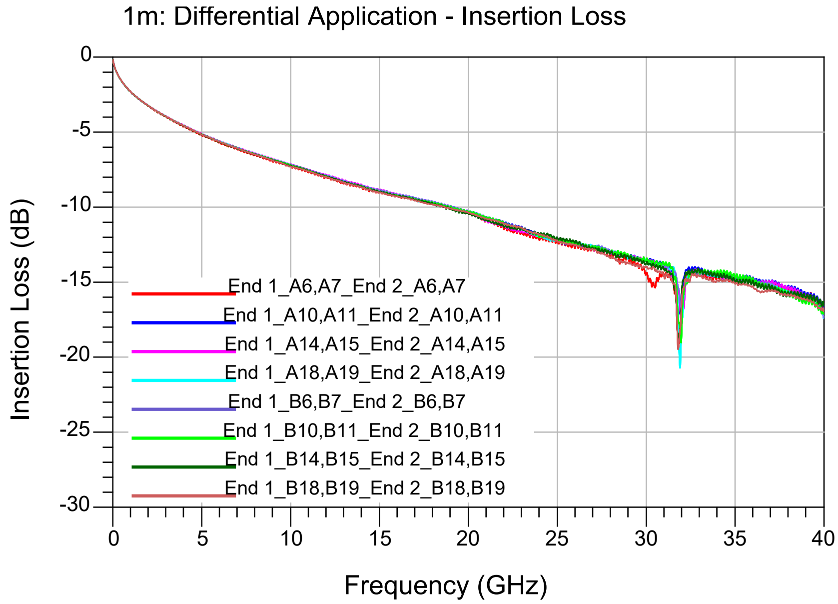


Figure 8

Differential Application – Return Loss

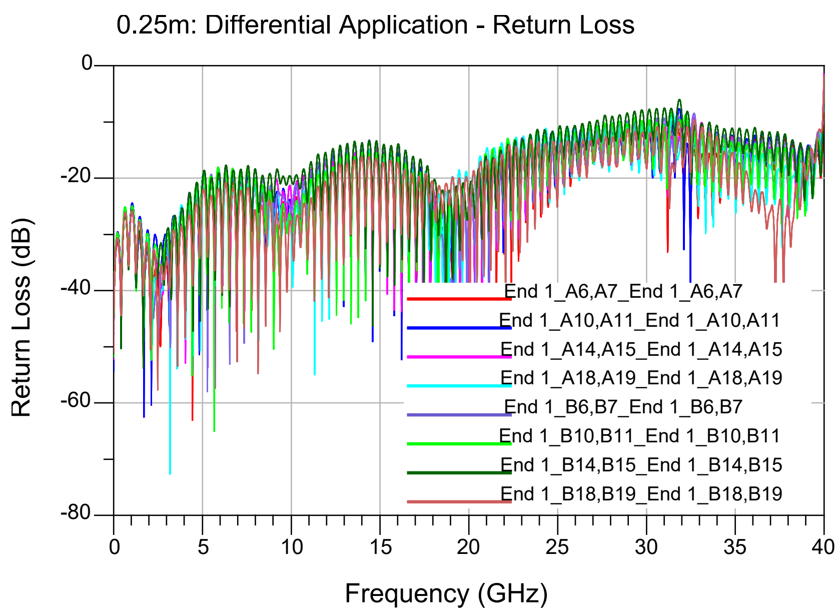


Figure 9

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

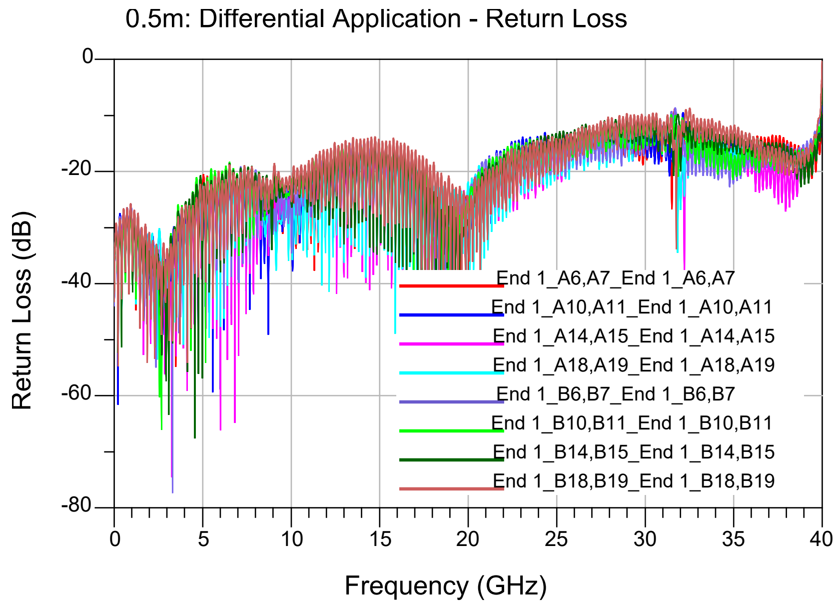


Figure 10

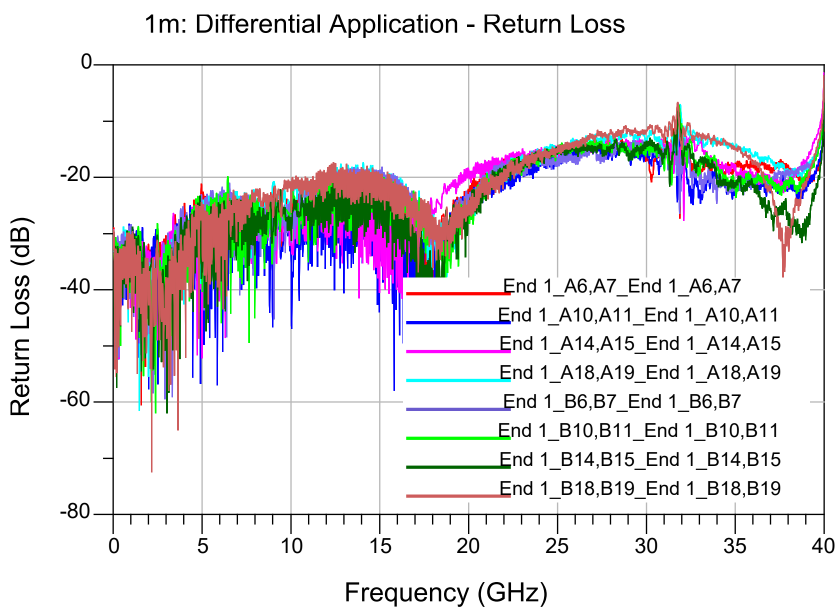


Figure 11

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Differential Application – NEXT Configurations

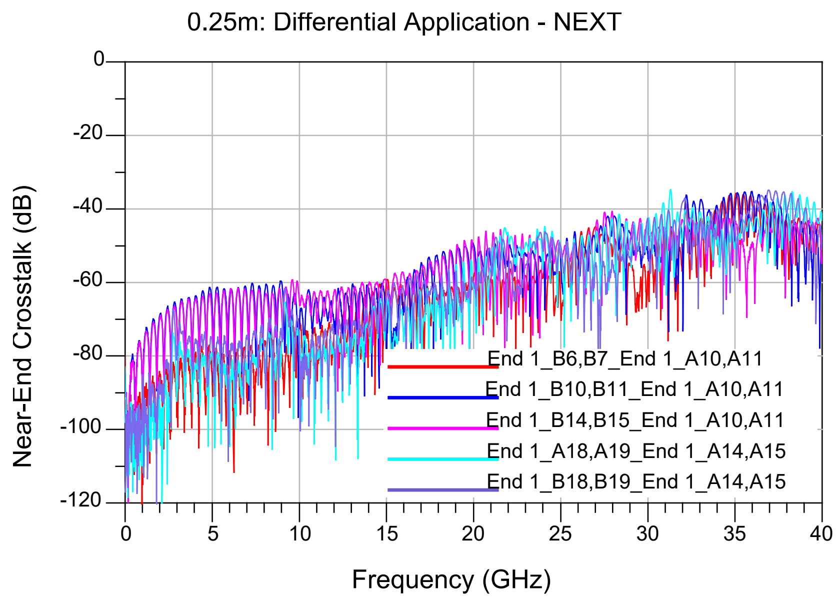


Figure 12

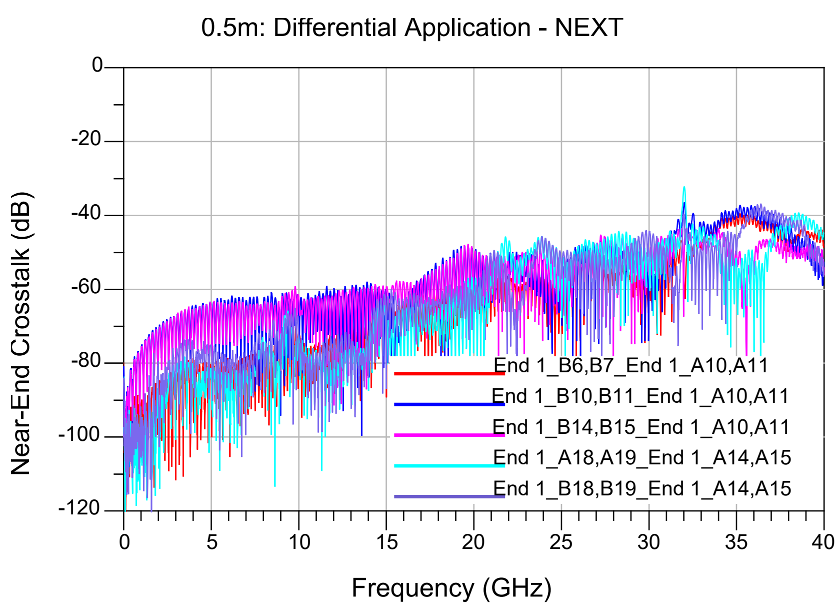


Figure 13

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

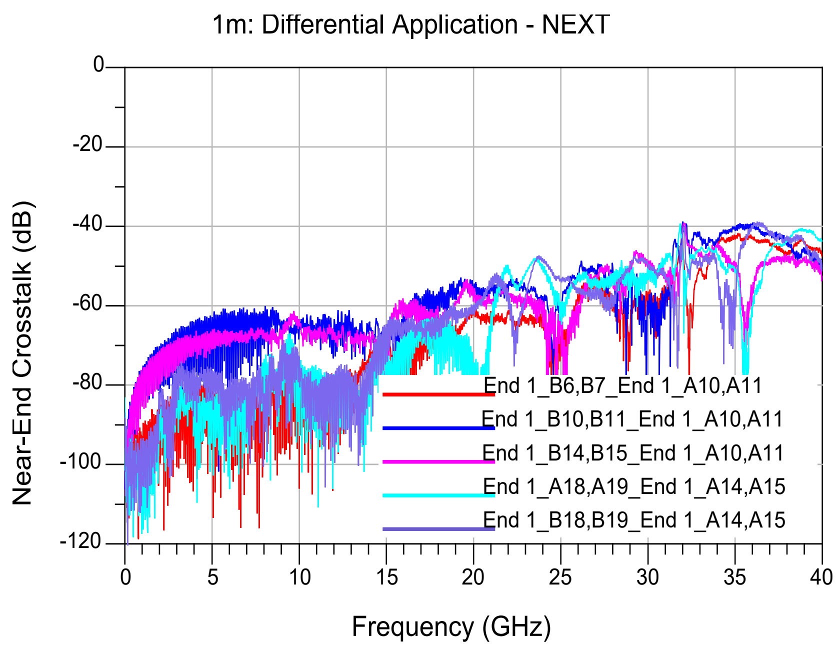


Figure 14

Differential Application – FEXT Configurations

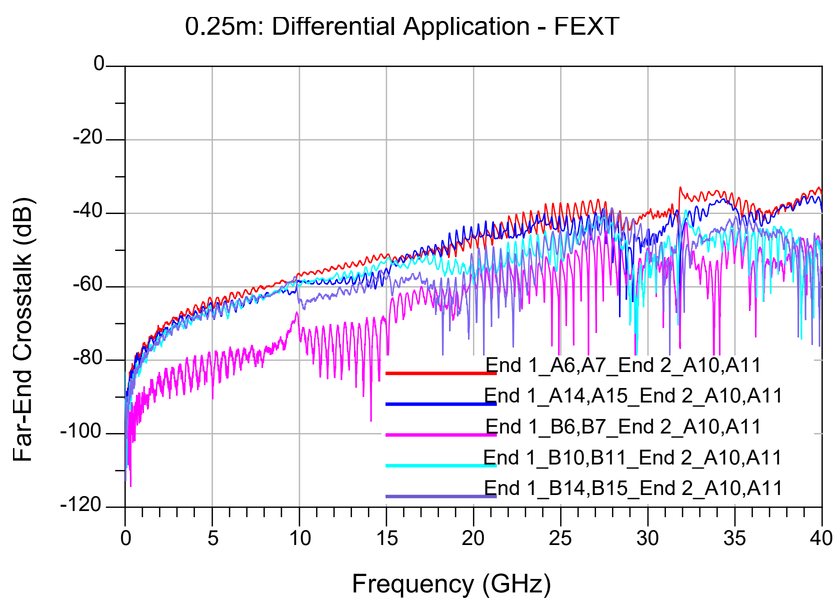


Figure 15

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

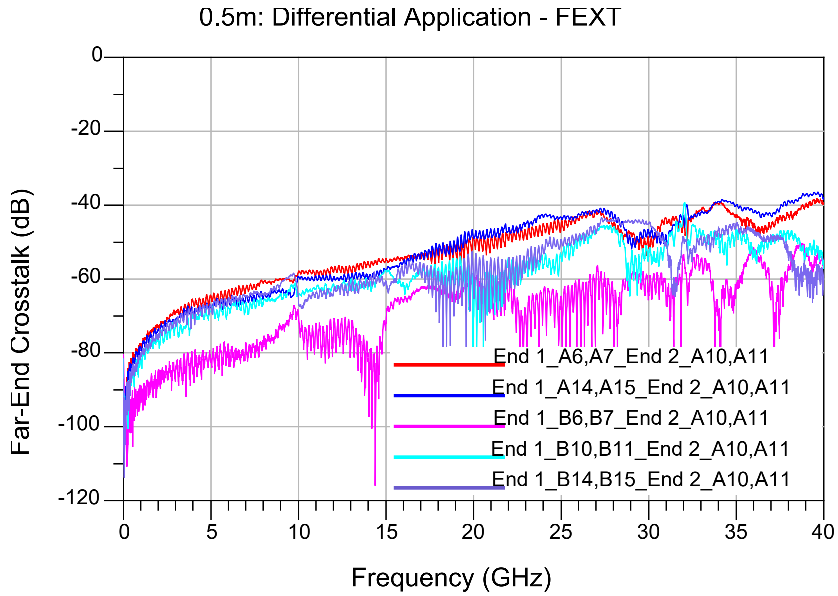


Figure 16

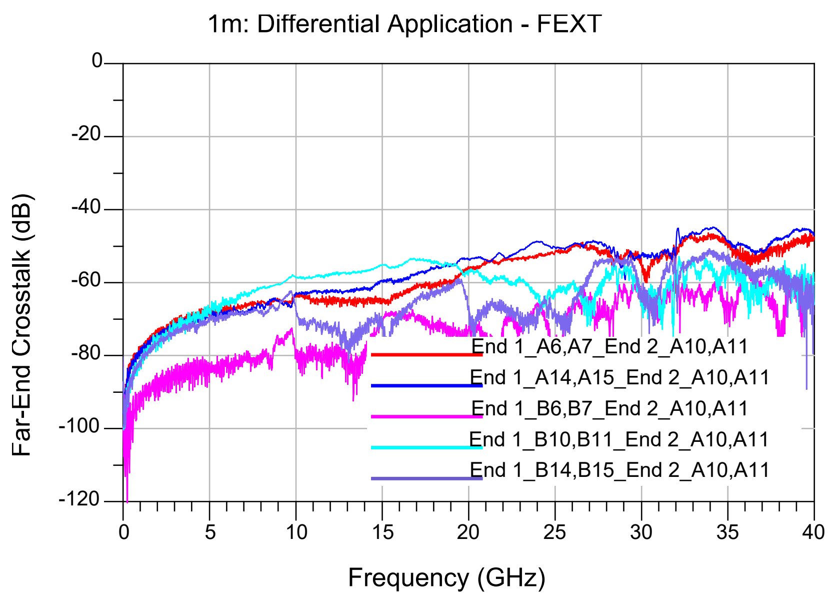


Figure 17

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Differential Application – Differential to Common Mode Conversion

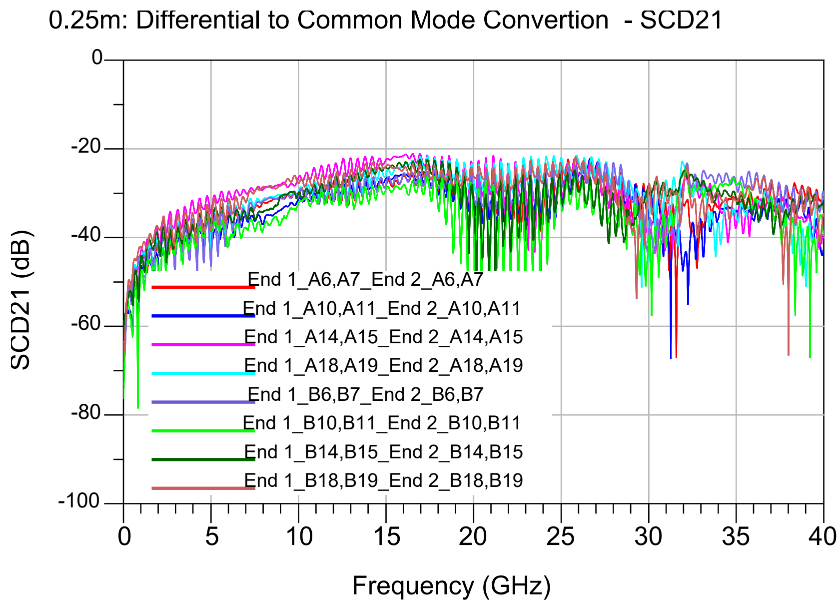


Figure 18

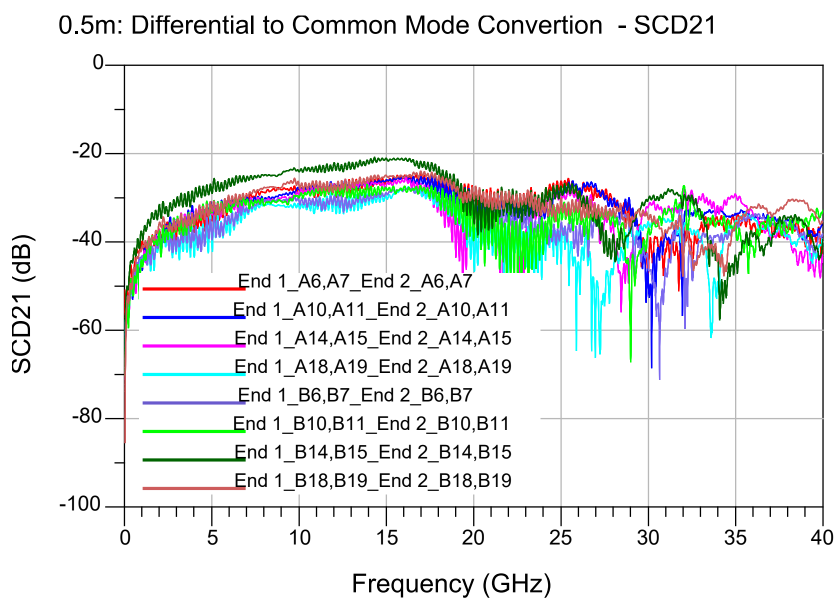


Figure 19

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

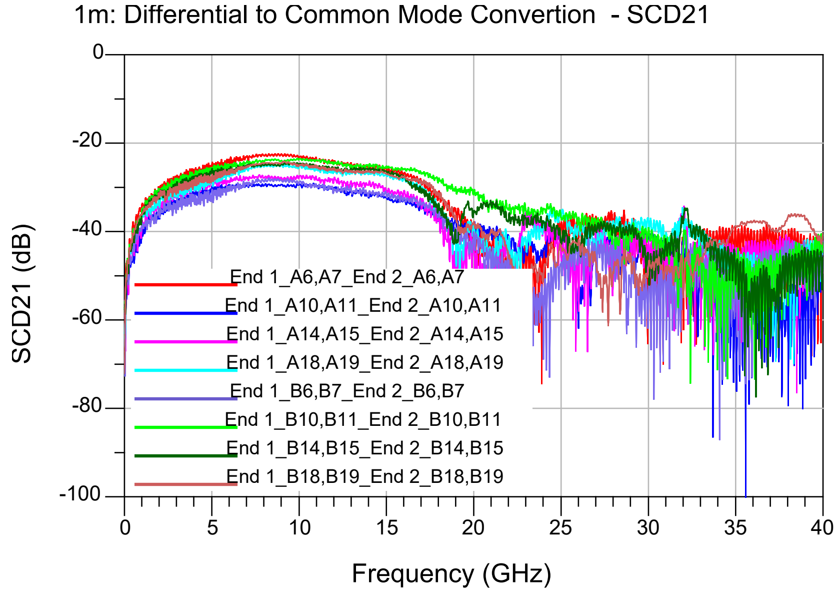


Figure 20

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Appendix B – Time Domain Responses

Differential Application – Input Pulse

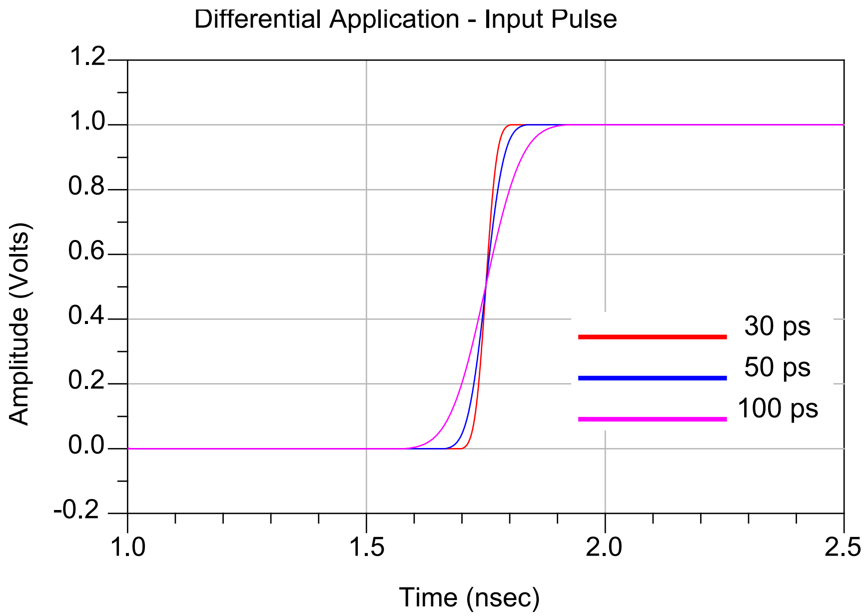


Figure 21

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Differential Application – Cable assembly Impedance

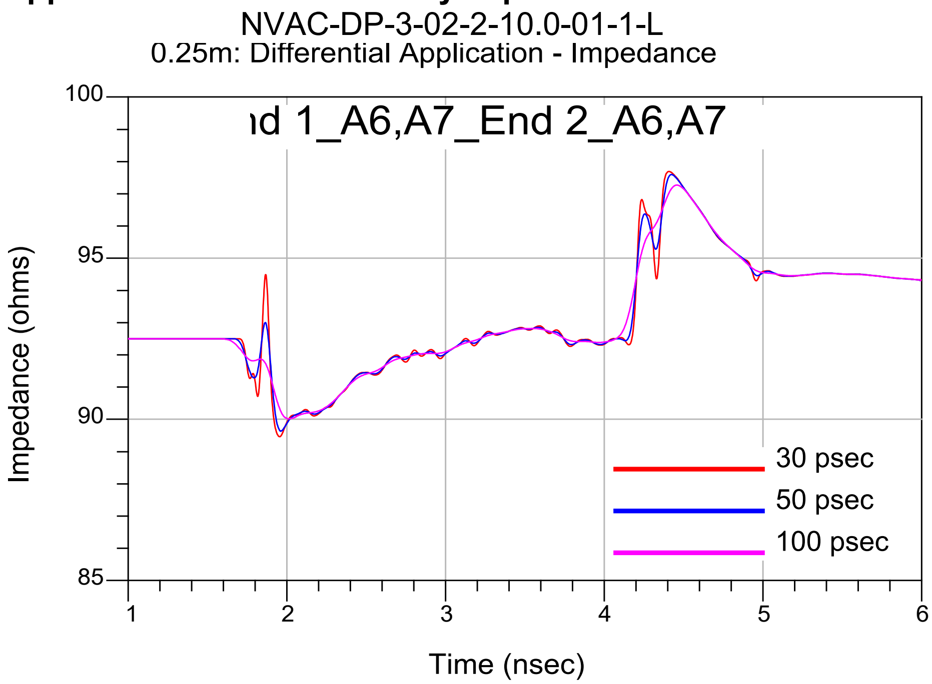


Figure 22

Differential Application – Cable assembly Impedance

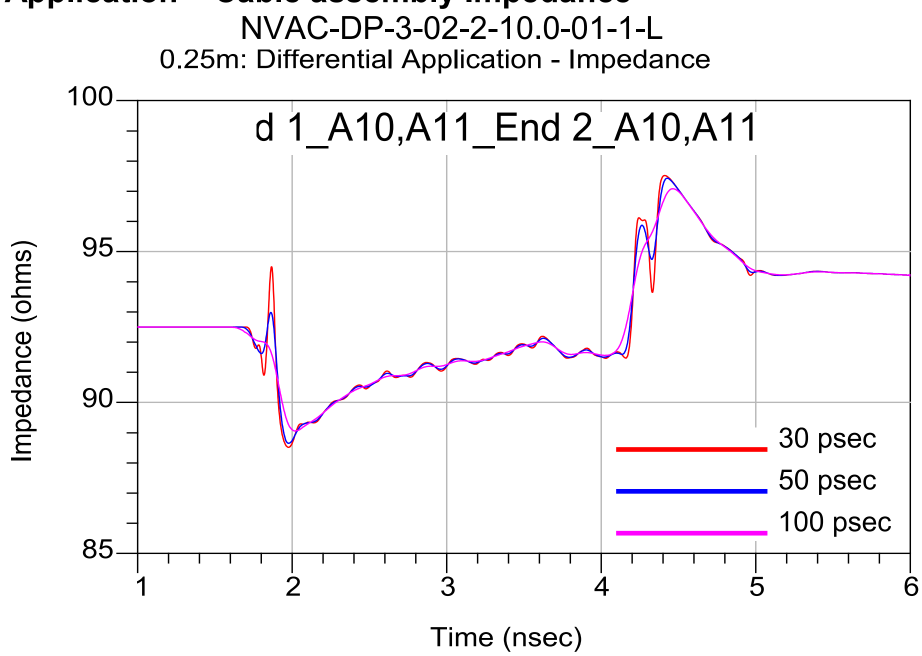


Figure 23

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

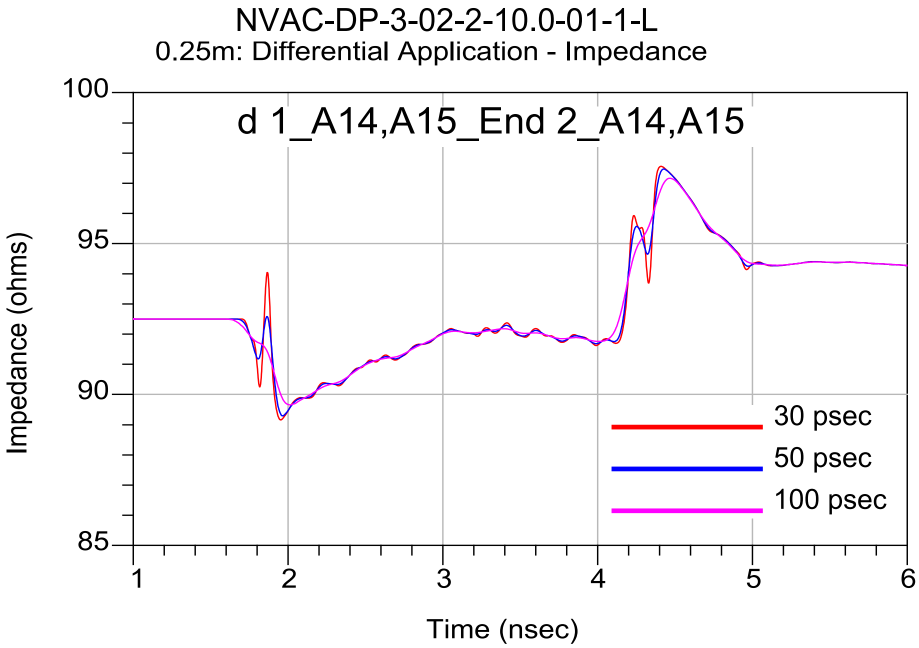


Figure 24

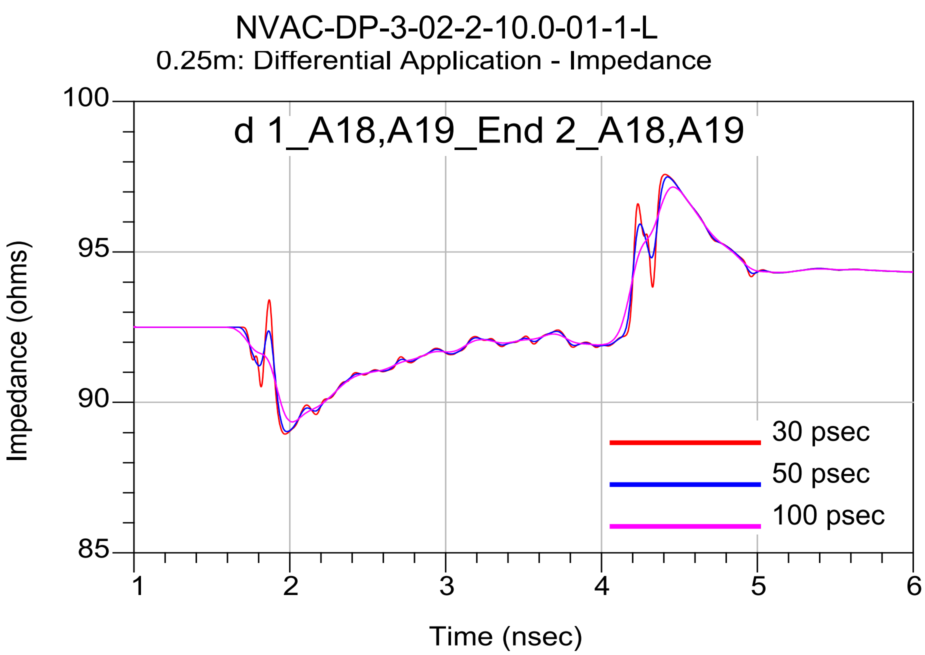


Figure 25

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

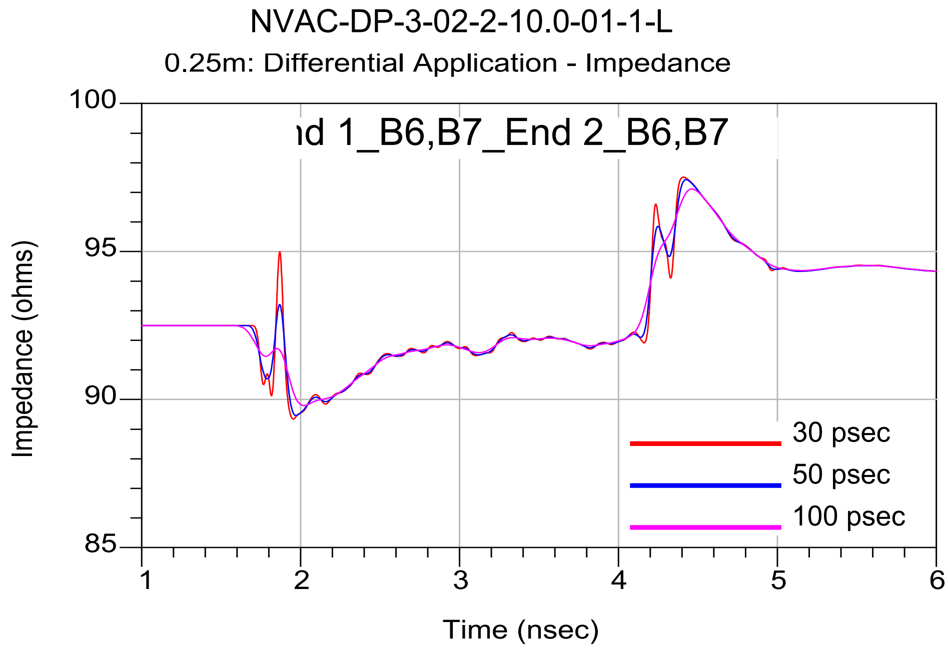


Figure 26

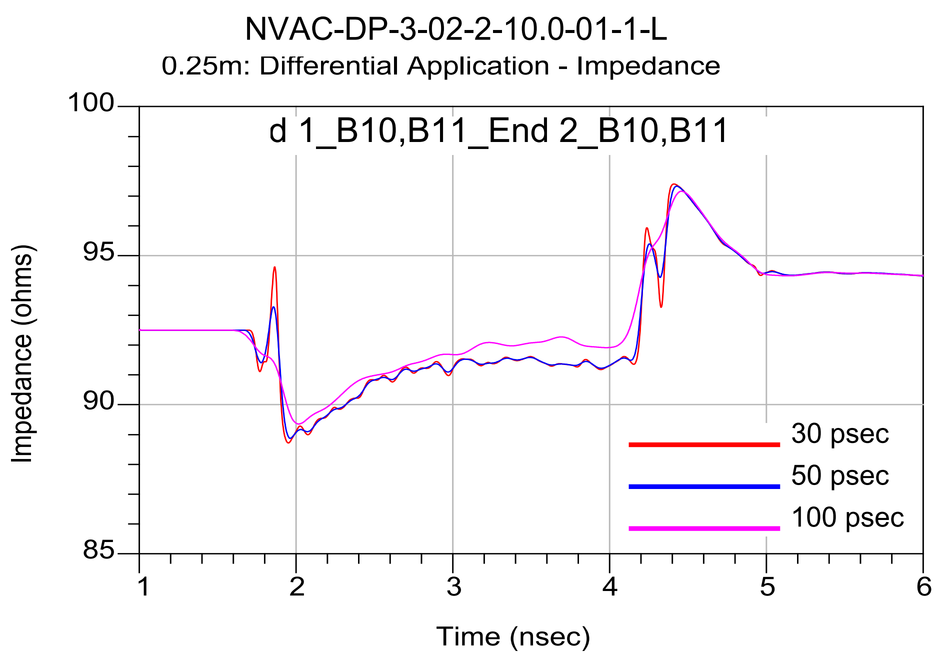


Figure 27

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

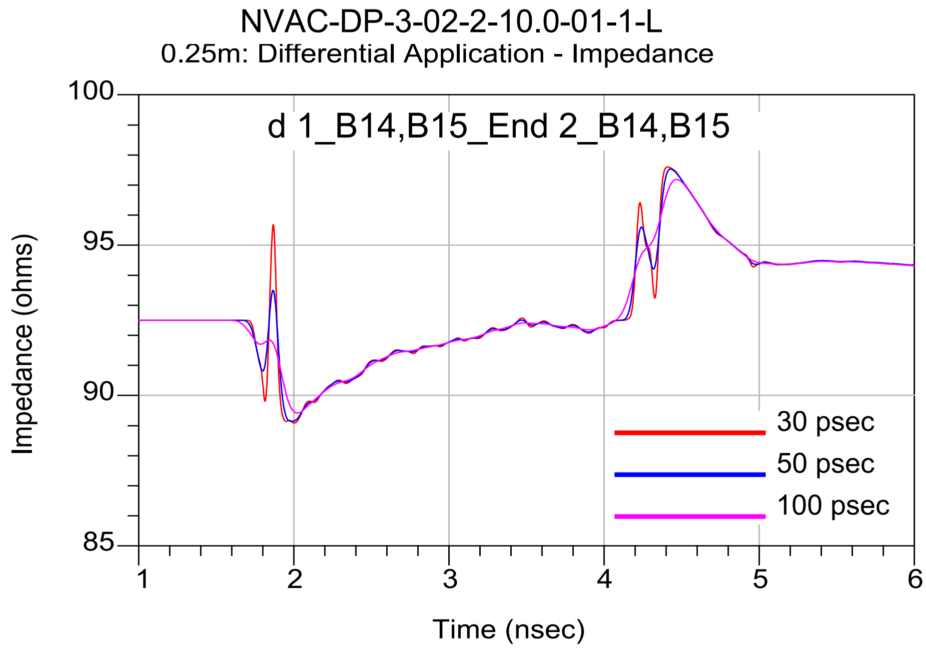


Figure 28

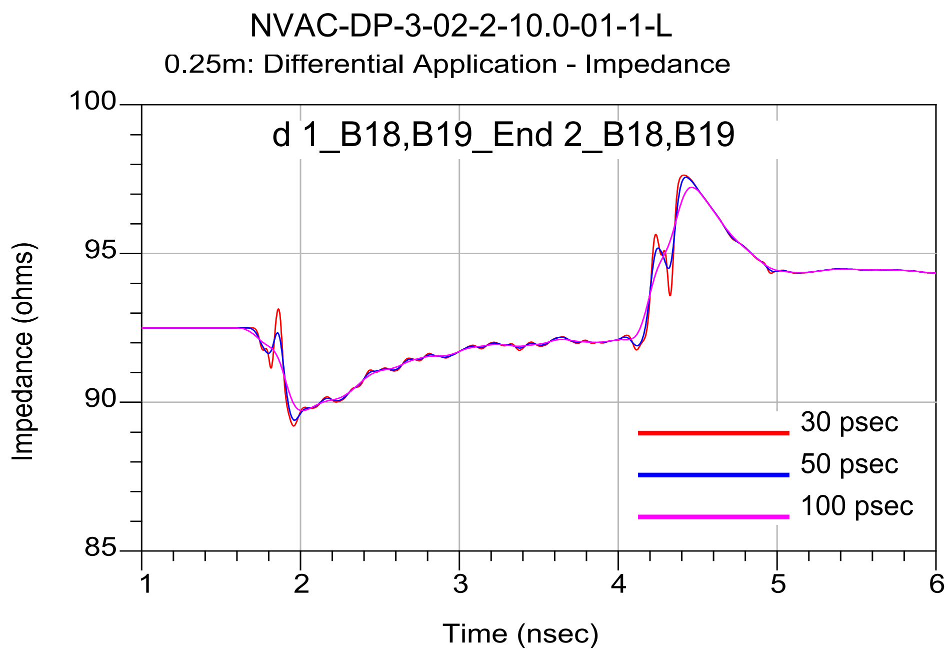


Figure 29

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Differential Application – Propagation Delay

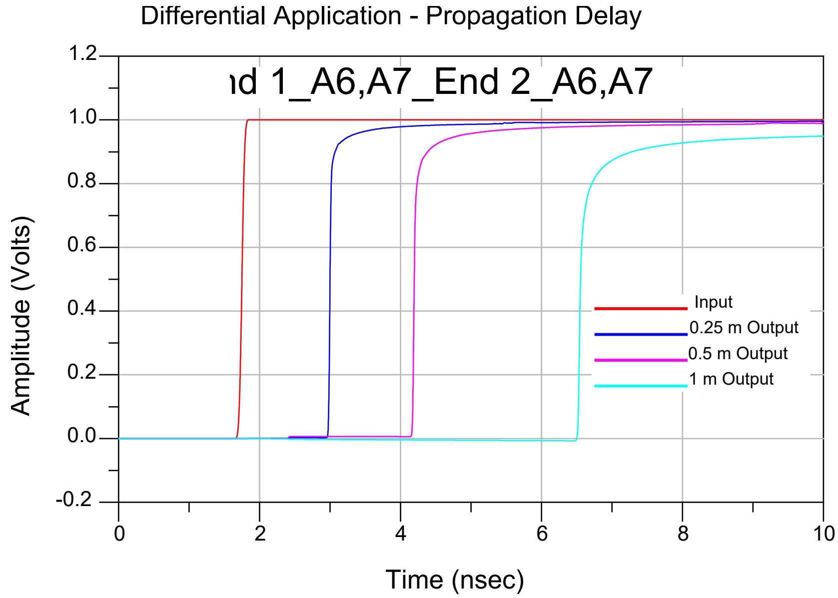


Figure 30

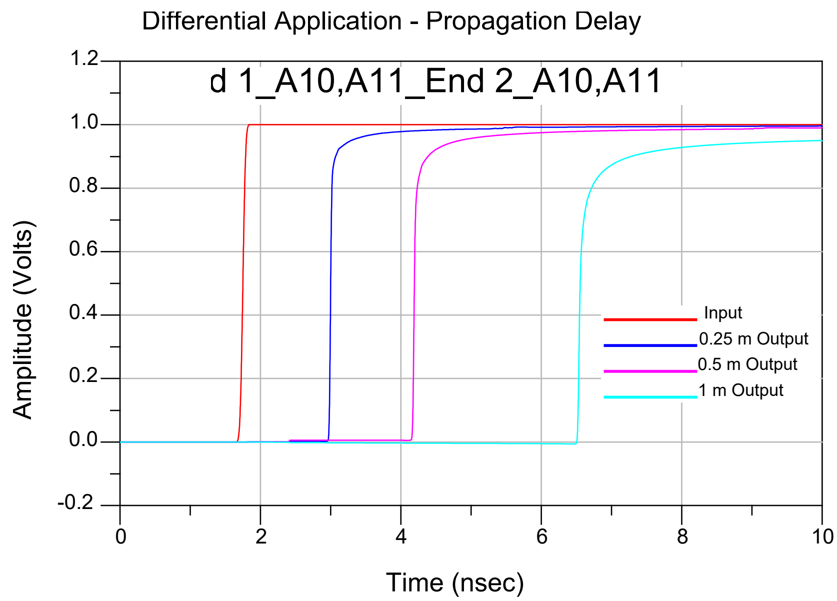


Figure 31

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

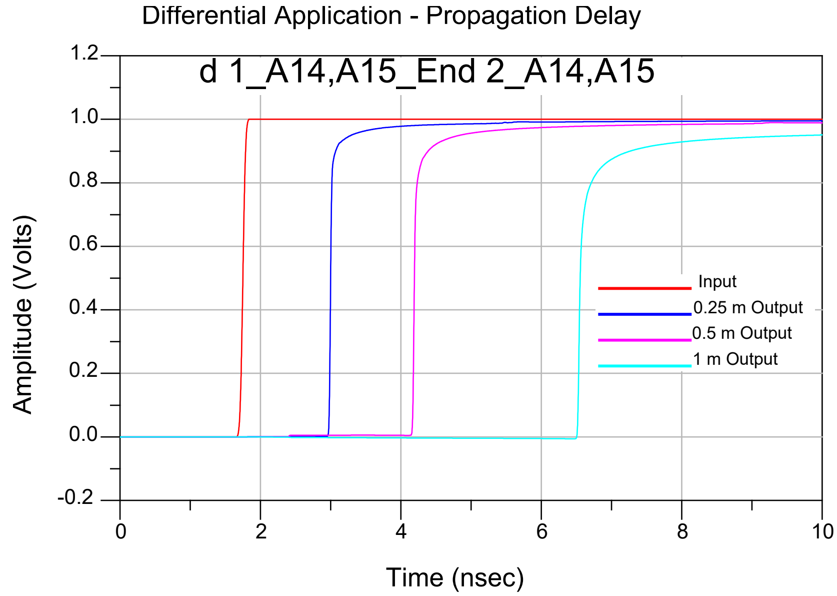


Figure 32

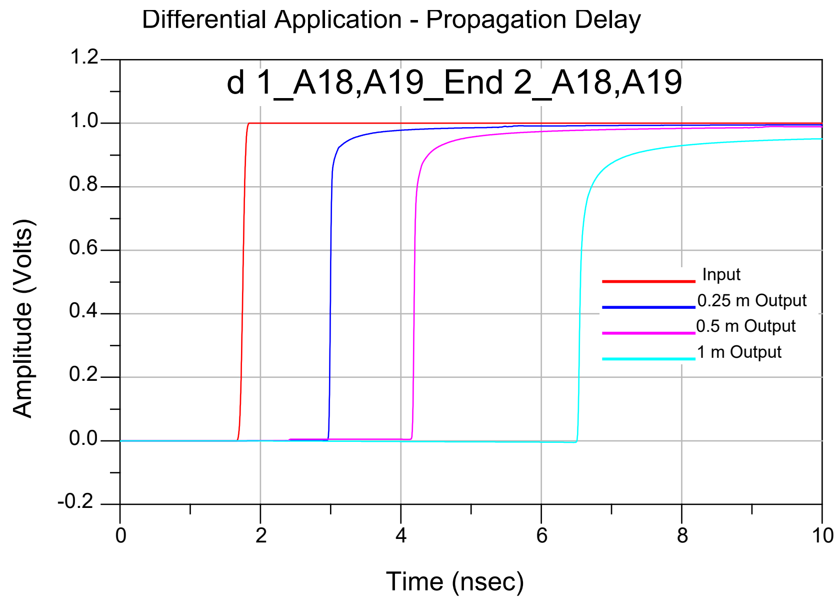


Figure 33

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Differential Application - Propagation Delay

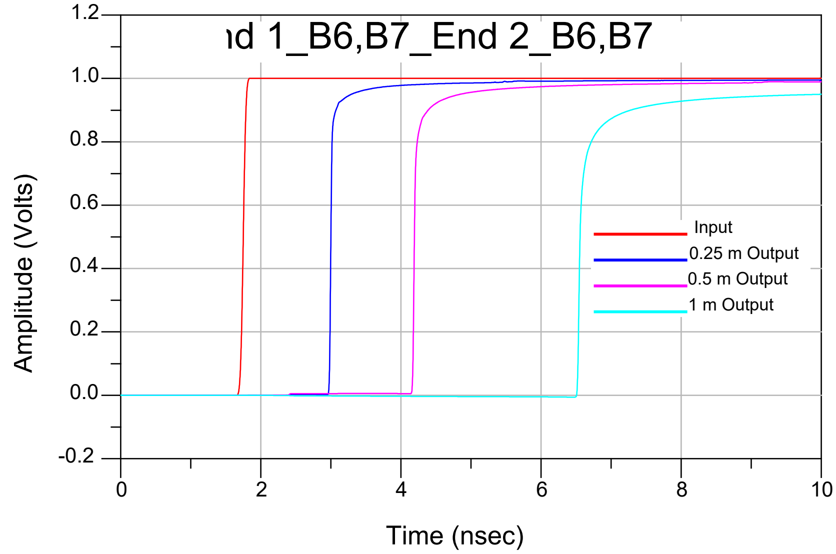


Figure 34

Differential Application - Propagation Delay

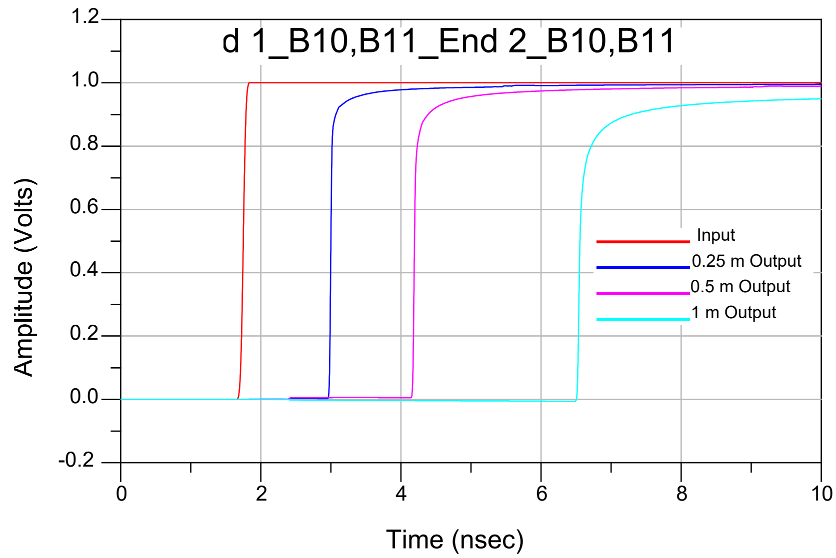


Figure 35

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

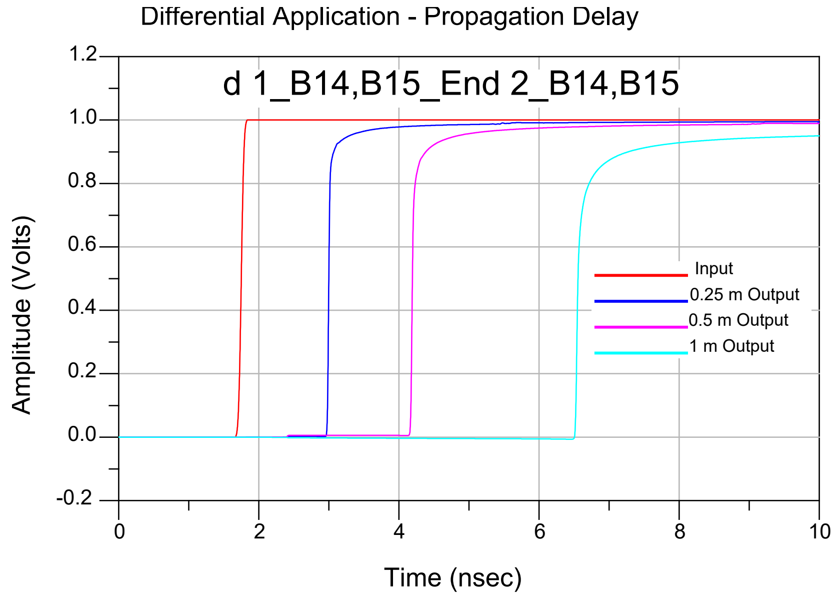


Figure 36

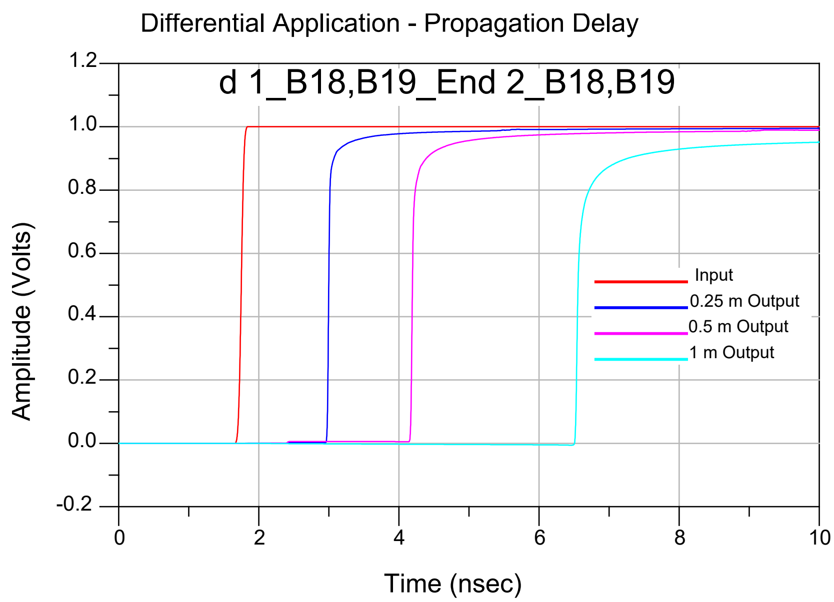


Figure 37

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Appendix C – Product and Test System Descriptions

Product Description

Product test samples are 0.8 mm NVAC Extreme Density and Performance Cable Assemblies. The part numbers are NVAC-DP-3-02-2-10.0-01-1-L, NVAC-DP-3-02-2-20.0-01-1-L and NVAC-DP-3-02-2-40.0-01-1-L. They mate with NVAM-DP-02-2-02.0-S-2-C. A photo of the mated test article mounted to SI test boards is shown below.

The cable assembly terminations had a particular signal line configuration. There is a total of 8 pairs per row, the signal line numbers are shown in Table 3.

	G	A2	A3	G	G	A6	A7	G	G	A10	A11	G	G	A14	A15	G	G	A18	A19	G	G	A22	A23	G	G	A26	A27	G	G	A30	A31	G
G	B2	B3	G	G	B6	B7	G	G	B10	B11	G	G	B14	B15	G	G	B18	B19	G	G	B22	B23	G	G	B26	B27	G	G	B30	B31	G	

Table 3 : Signal line numbers

Test System Description

The test fixtures are composed of six-layer PSR-4000-BN material with 46.25Ω signal trace and pad configurations designed for the electrical characterization of Samtec high speed cable assembly products. A PCB mount 2.4mm connector is used to interface the PNA test cables to the test fixtures. Optimization of the 2.4mm launch was performed using full wave simulation tools to minimize reflections. The test fixtures and calibration kit are specific to the NVAC series connector set and identified by part number PCB-NVAM-109157-SIG-0.

PCB-NVAM-109157-SIG-0 Test Fixtures

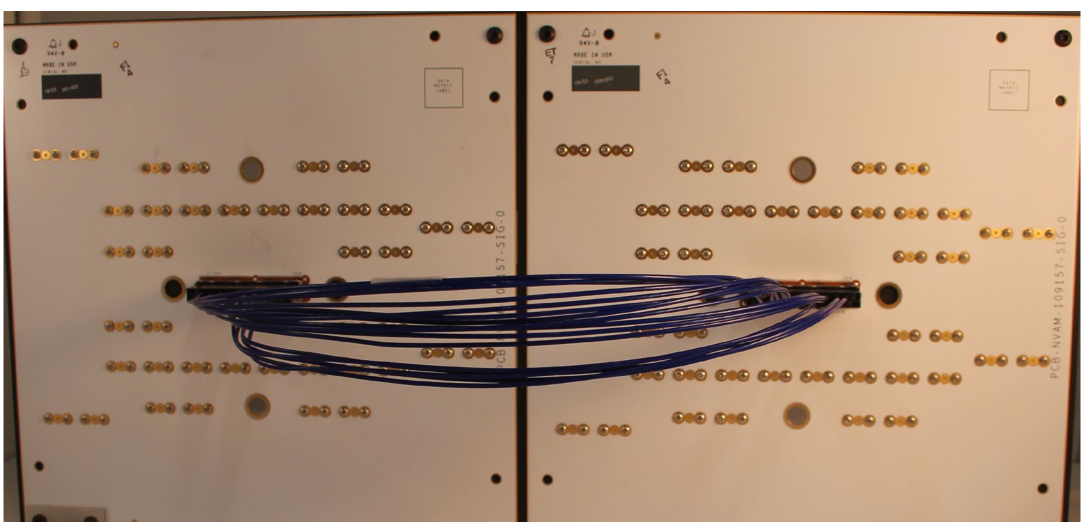


Figure 38

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

PCB Fixtures
The test fixtures used are as follows:

PCB-NVAM-109157-SIG-0 – NVAC Cable Test Board

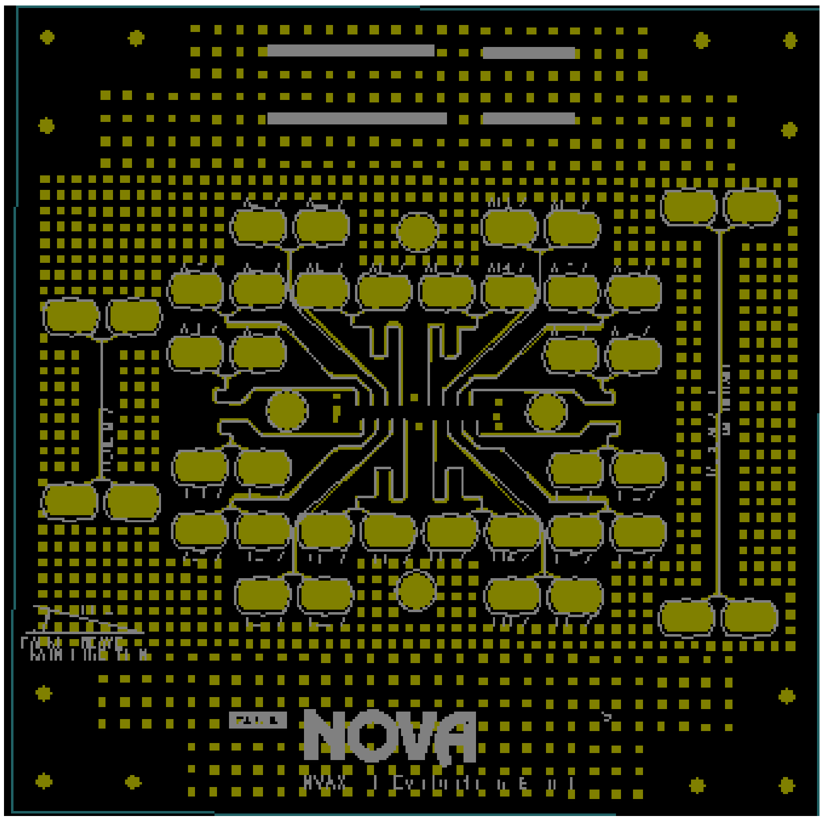


Figure 39

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Appendix D – Test and Measurement Setup

For frequency domain measurements, the test instrument is the Agilent N5225B PNA-L network analyzer. Frequency domain data and graphs are extracted from the instrument by AFR application. The network analyzer is configured as follows:

Start Frequency – 10 MHz
Stop Frequency – 40 GHz
IFBW – 1 KHz

N5225B Measurement Setup

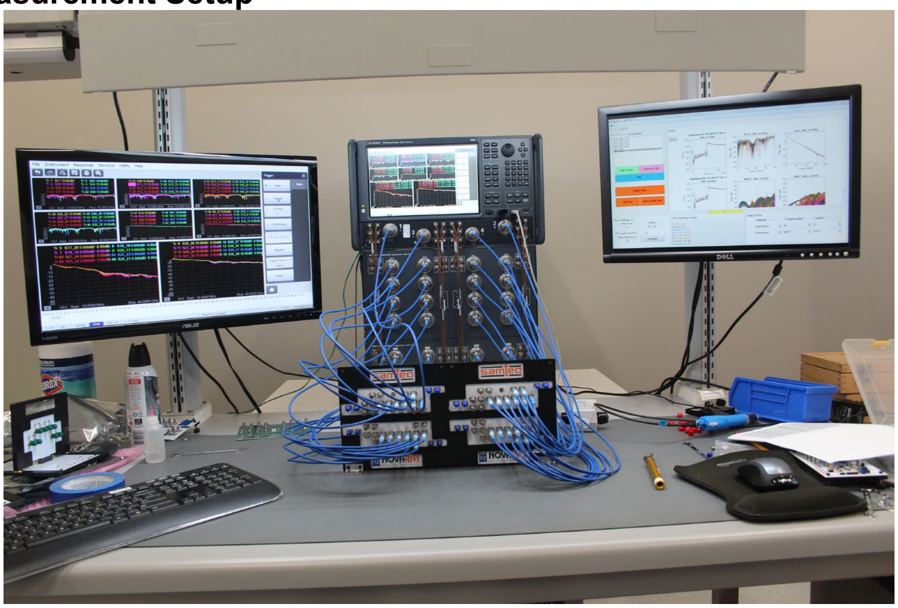


Figure 40

Test Instruments

QTY	Description
1	Agilent N5225B PNA-L Network Analyzer (10 MHz to 40 GHz)
1	Agilent N4694-60003 ECAL Module (10 MHz to 40 GHz)

Test Cables & Adapters

QTY	Description
4	1m Junkosha 2.4mm male to female cables (DC to 40 GHz)

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Appendix E - Frequency and Time Domain Measurements

Frequency (S-Parameter) Domain Procedures

The quality of any data taken with a network analyzer is directly related to the quality of the calibration standards and the use of proper test procedures. For this reason, extreme care is taken in the design of the through calibration standards, the SI test boards, and the selection of the PCB vendor.

A coaxial SOLT calibration is performed using 8770D ECAL module. Then DUT measurements are performed under SOLT calibration. The measurements include the effect of test fixture. The measurements of the 2X THRU line standards are required to remove the test fixture effect.

Time Domain Procedures

Mathematically, Frequency Domain data can be transformed to obtain a Time Domain response. Perfect transformation requires Frequency Domain data from DC to infinity Hz. Fortunately, a very accurate Time Domain response can be obtained with bandwidth-limited data, such as measured with modern network analyzer.

The Time Domain responses were generated using Keysight ADS 2017 update 1. This tool has a transient convolution simulator, which can generate a Time Domain response directly from measured S-Parameters. An example of a similar methodology is provided in the Samtec Technical Note on domain transformation.
http://suddendocs.samtec.com/notesandwhitepapers/tech-note_using-plts-for-time-domain-data_web.pdf

Impedance (TDR)
A step pulse is applied to the touchstone model of the connector and the reflected voltage is monitored. The reflected voltage is converted to a reflection coefficient and then transformed into an impedance profile. All ports of the Touchstone model are terminated in 46.25 ohms.

Propagation Delay (TDT)

The Propagation Delay is a measure of the Time Domain delay through the cable assembly and footprint. A step pulse is applied to the touchstone model of the cable assembly and the transmitted voltage is monitored. The same pulse is also applied to a reference channel with zero loss, and the Time Domain pulses are plotted on the same figure.

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

The difference in time, measured at the 50% point of the step voltage is the propagation delay.

Impedance (TDR)

Measurements involving digital pulses are performed using either Time Domain Reflectometer (TDR) or Time Domain Transmission (TDT) methods. The TDR method is used for the impedance measurements in this report.

The signal line(s) of the SUT's is energized with a TDR pulse and the far-end of the energized signal line is terminated in the test systems characteristic impedance (e.g.; 50Ω or 100Ω terminations). By terminating the adjacent signal lines in the test systems characteristic impedance, the effects on the resultant impedance shape of the waveform is limited.

Samtec Inc.
520 Park East Blvd.
New Albany IN 47151-1147 USA

WWW.SAMTEC.COM
1-800-SAMTEC-9 (US & Canada)
SIG@samtec.com

Phone: 812-944-6733
Fax: 812-948-5047
Report Revision: 09/07/2020

Series: NVAC (2-row, 2-bank, 92-ohm Twinax Cable)
Description: 0.80 mm NovaRay® Extreme Density & Performance Socket Cable Assembly

Appendix F – Glossary of Terms

ADS – Keysight Advanced Design System
AFR – Automatic Fixture Removal
PCB – Printed Circuit Board
SUT – System Under Test
SOLT – acronym used to define Short, Open, Load & Thru Calibration Standards
TDR – Time Domain Reflectometry
TDT – Time Domain Transmission